Study of Regional Climate Change

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- To diagnose and improve global and regional GCMs for simulating observed *regional* climate characteristics, and for studying *regional* climate changes caused by anthropogenic activities (greenhouse gases, aerosols, ozone).
- Focused Regions (climate features): East Asia (summer monsoon); and Northeastern United States (winter cold surges)

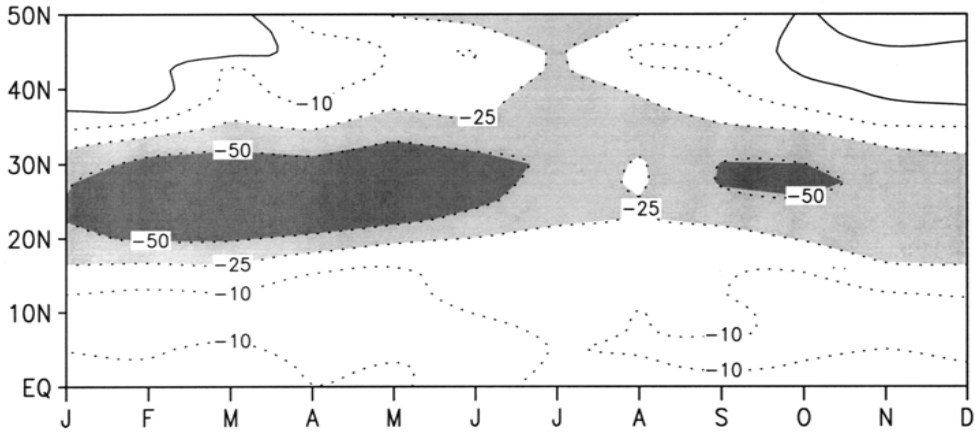
Topical Studies

- Cloud-Climate Interaction [SUNYA global and regional climate model]
  - Wang, et al., 2003: Characteristics of cloud radiative forcing over East Asia. *J. Climate*, EAC Special Issue (in press)
- Annual & Interannual Climate Variability [Analysis of AMIP-CMIP simulations; East Asia Climate (EAC) subproject]
  - Liang et al., 2002: China rainfall interannual predictability: Dependence on the annual cycle and surface anomalies. *J. Climate, 17,* 2555-1561.
- Decadal Climate Variability [Historical climate reconstruction in China]
  - Ge, et al., 2003: Winter half-year temperature reconstruction for the middle and lower reaches of the Yellow river and Yangtze river during the past 2000-years. *Holocene, 13,* 995-1002.

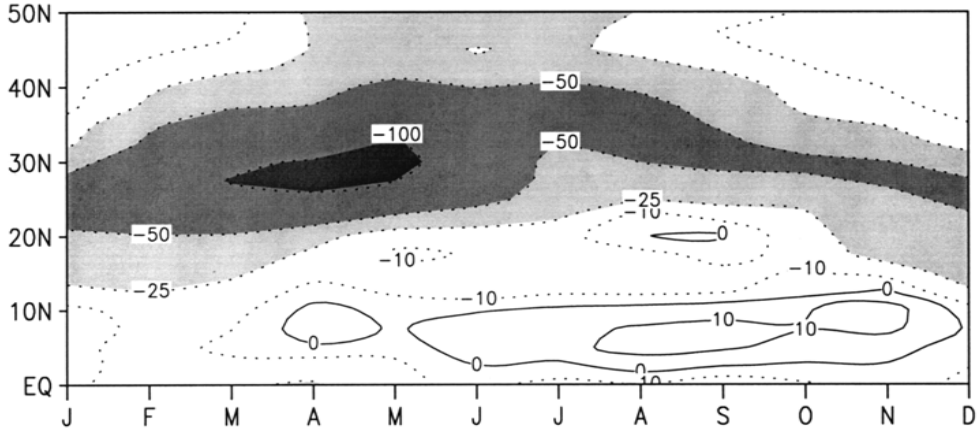
=>**500 Years of East Asian Monsoon Variability: A Test of Model Simulations with Paleoclimate Data**

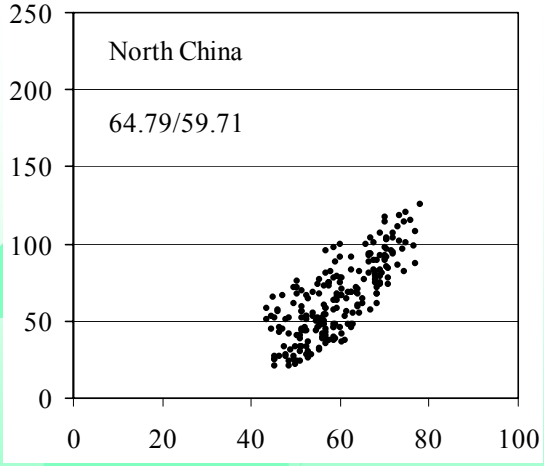
1985-1989 mean annual cycle of net (longwave & shortwave) cloud radiative forcing (Wm^{-2}) over 105-122° E

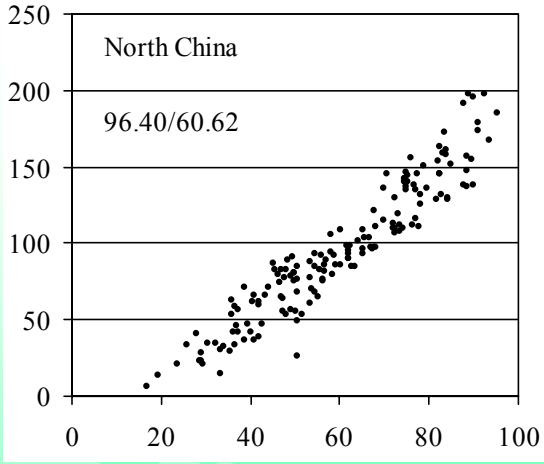
ERBE

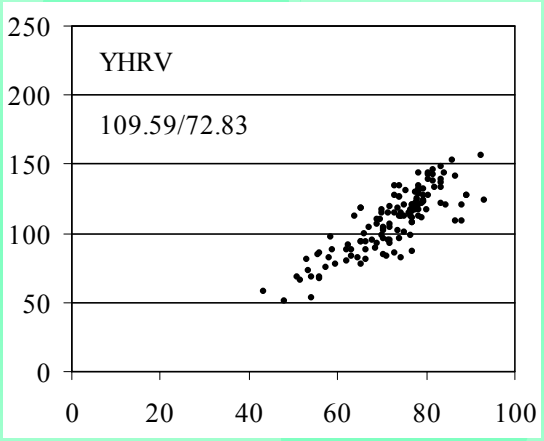


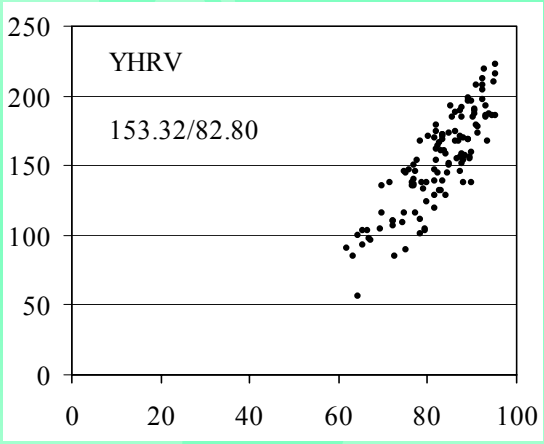
SUNYA-CCM3

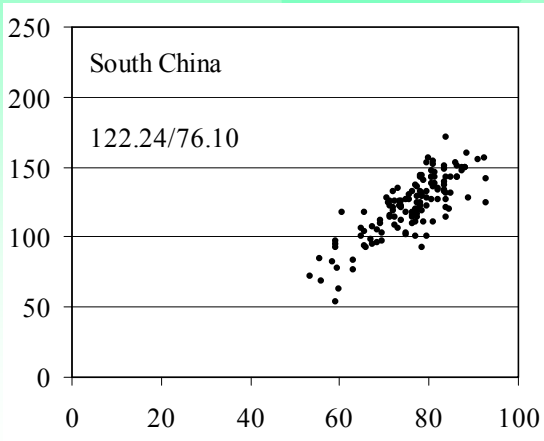


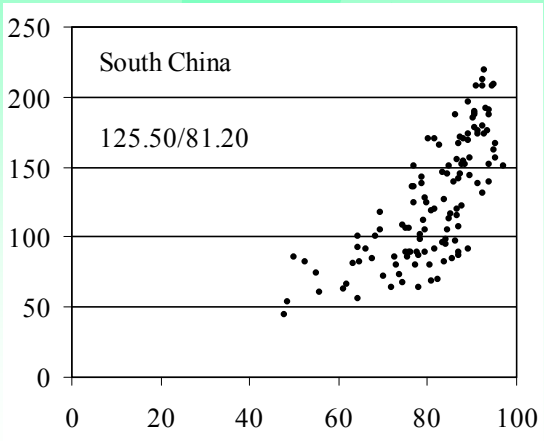




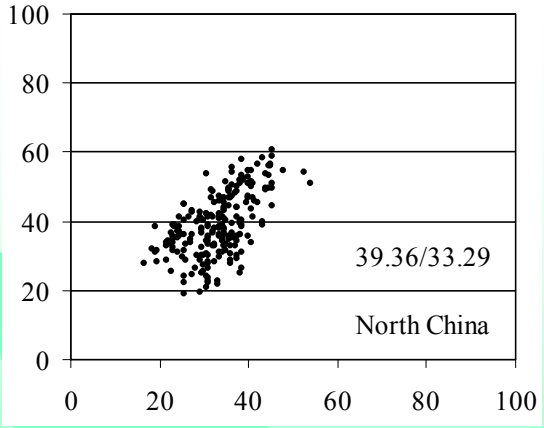


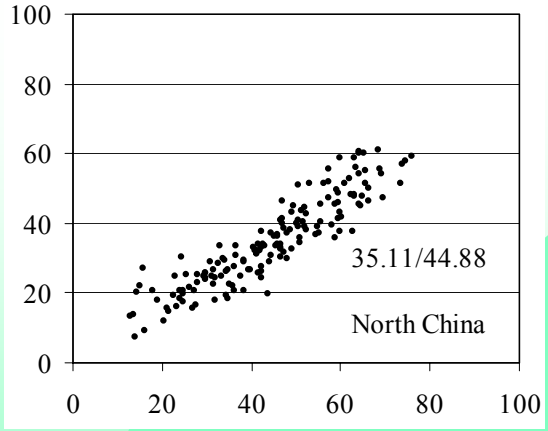


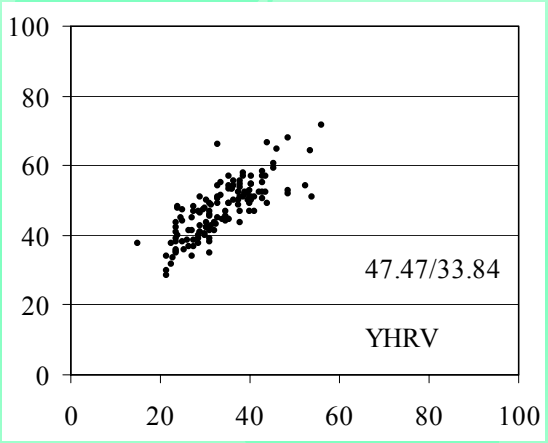


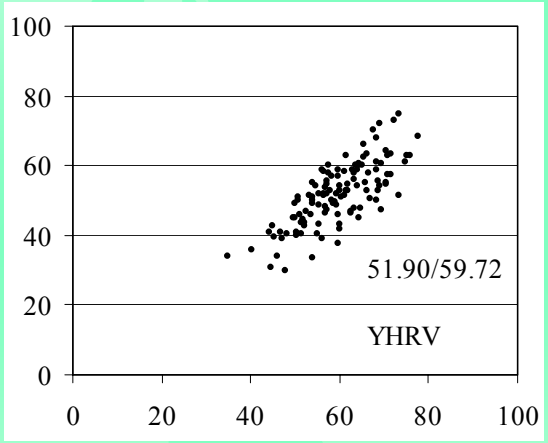


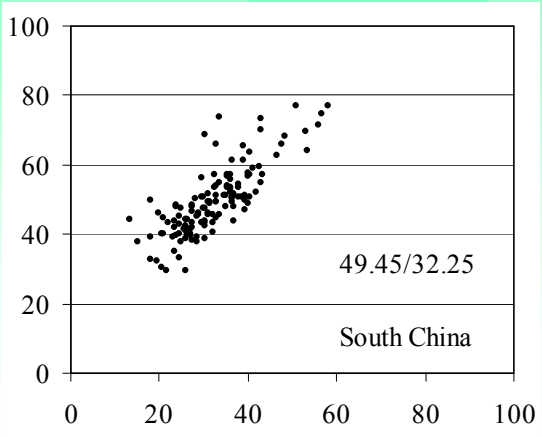
Shortwave cloud radiative forcing (Wm^{-2}; y-axis) versus ***total cloudiness*** (%) for observations (left panels) and SUNYA-CCM3 simulations (right panels).

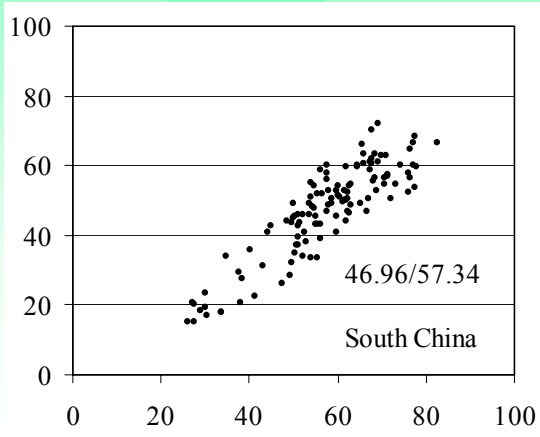












Longwave cloud radiative forcing (Wm^{-2}; y-axis) versus ***high cloudiness*** (%) for observations (left panels) and SUNYA-CCM3 simulations (right panels).

Historical Climate Reconstruction in China

- Collaboration between the Atmospheric Sciences Research Center, State University of New York at Albany and the Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences
- , Chinese Academy of Sciences
  - Documentation
  - Analysis of Proxy Data
  - *GCM-Proxy Data Comparison*

500 Years of East Asian Monsoon Variability: A Test of Model Simulations with Paleoclimate Data

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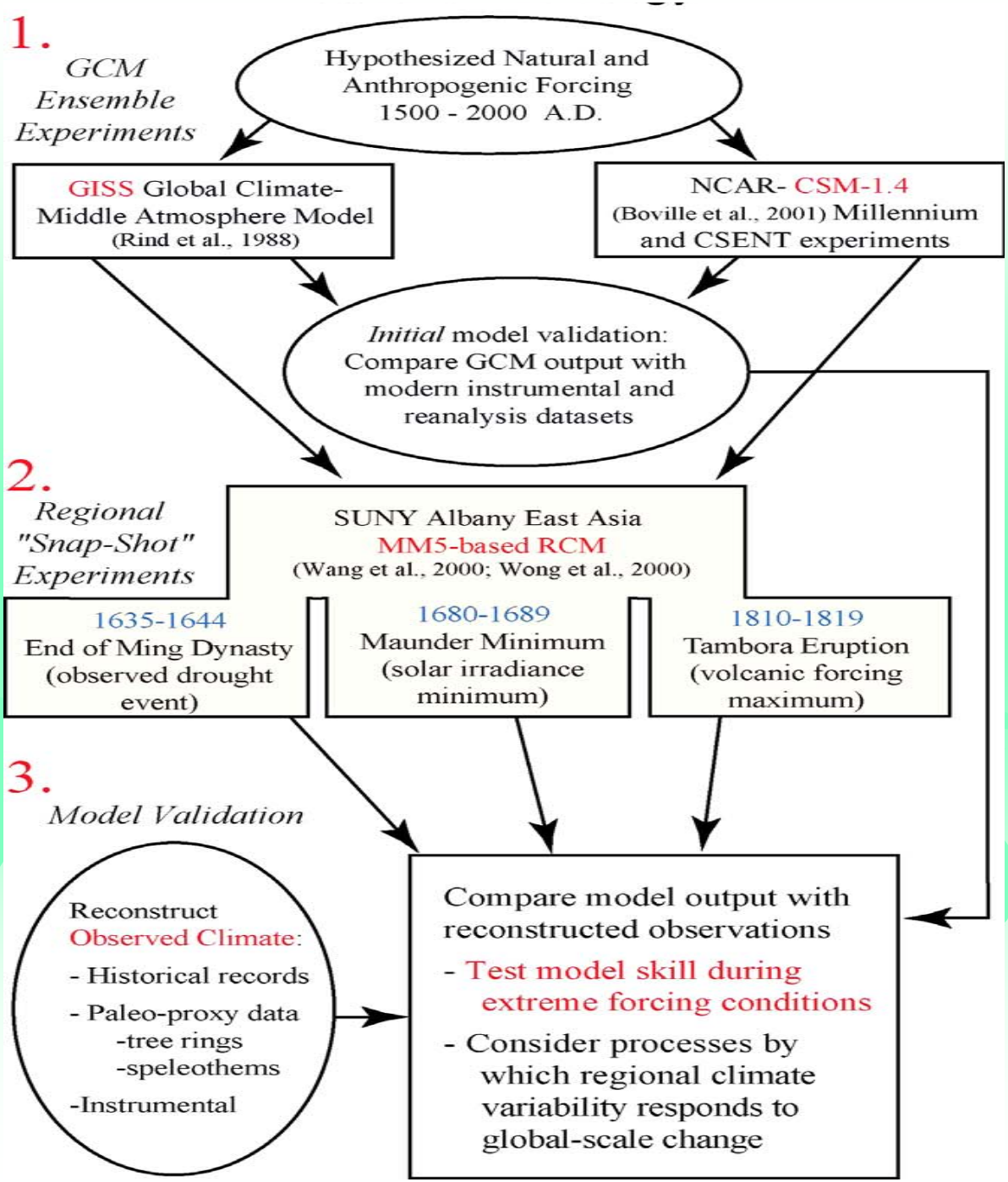
David Rind

NASA Goddard Institute for Space Studies, New York, NY

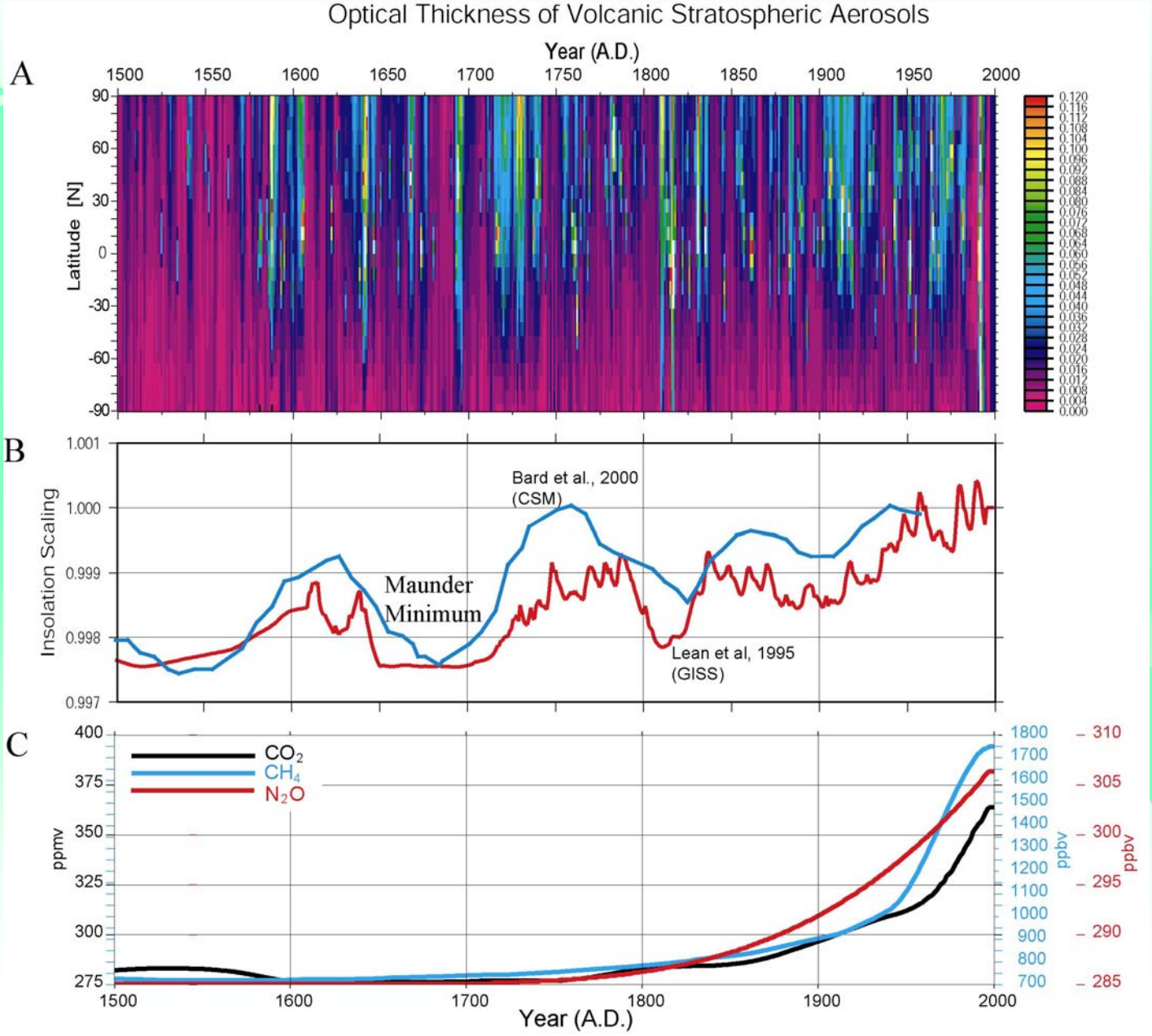
Richard Healy

Woods Hole Oceanographic Institution, Woods Hole, MA

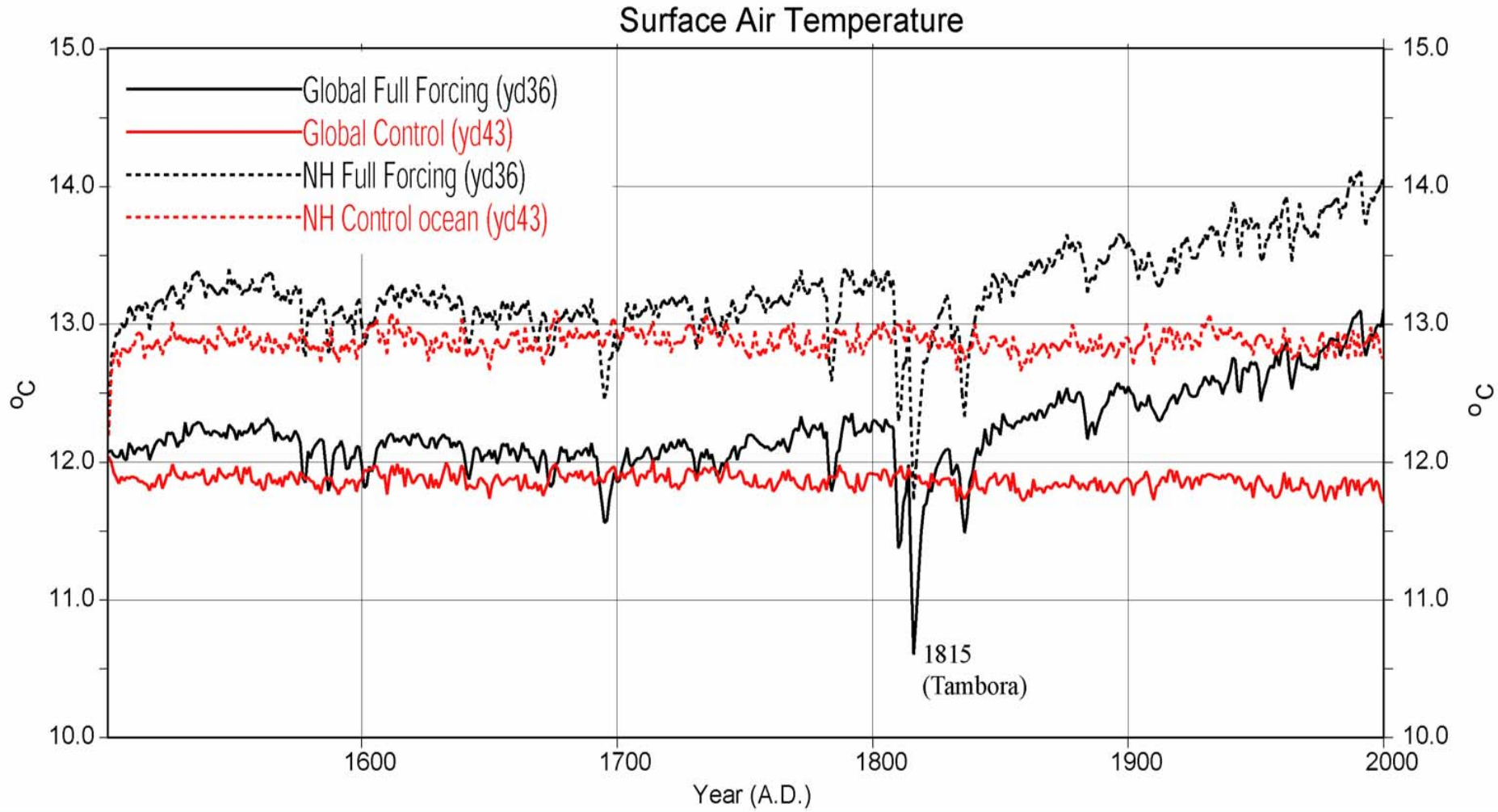
Research Strategy



Natural and Anthropogenic Forcing

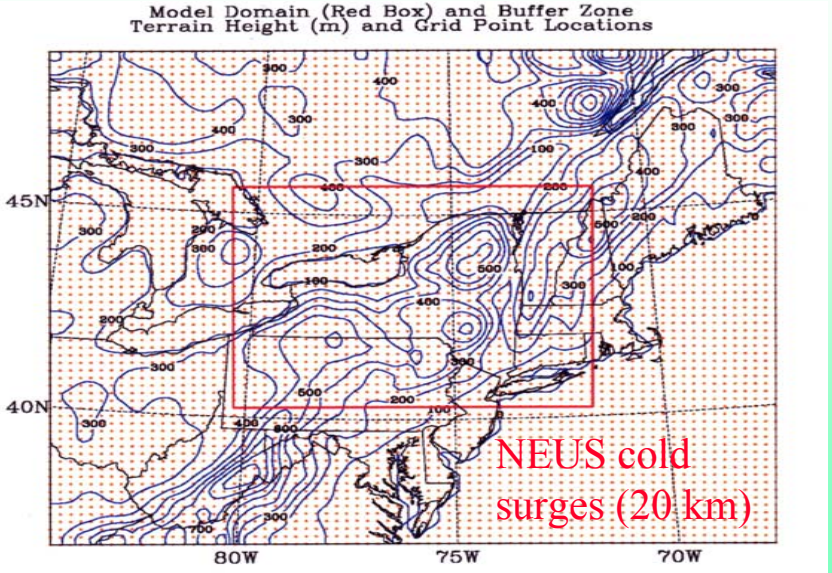


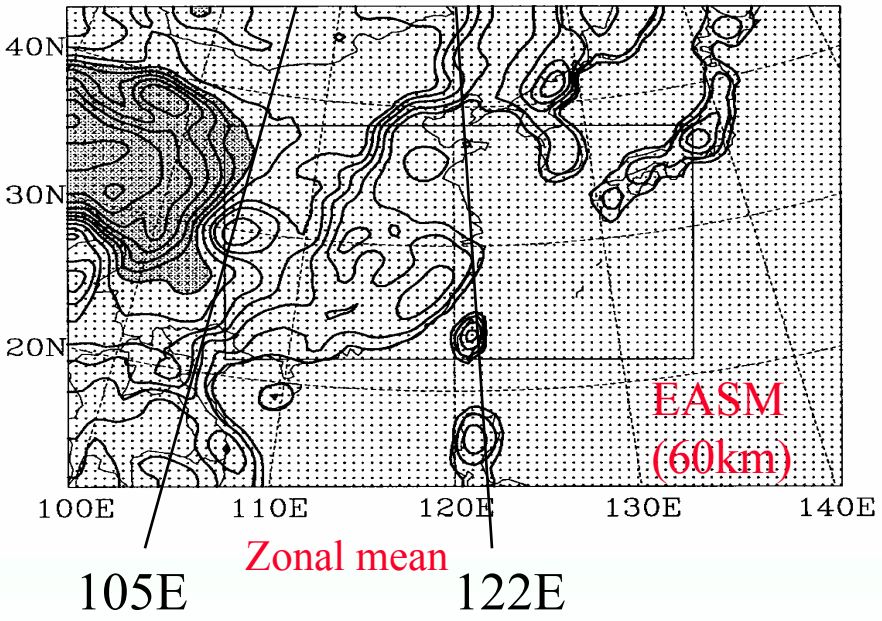
GISS GCM Global and Northern Hemisphere Temperature (forced and control experiments)

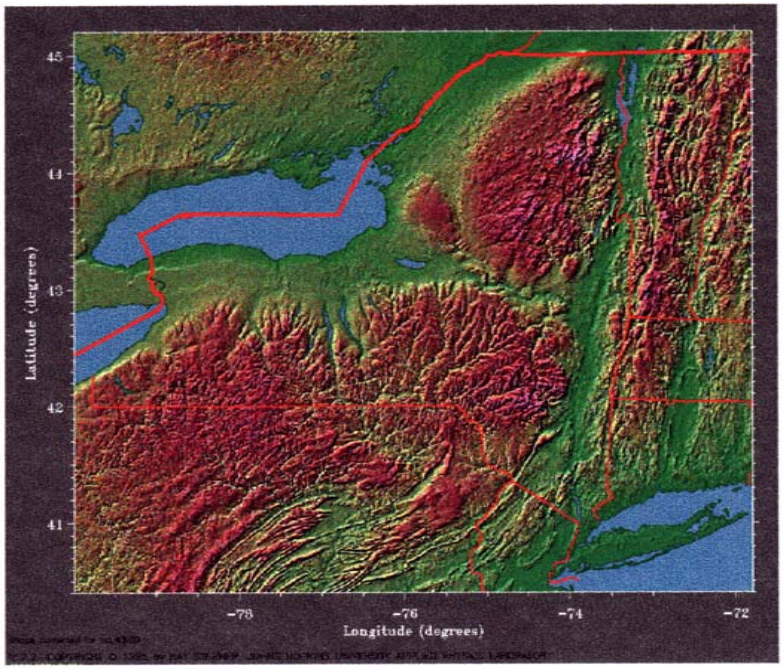


SUNYA-Regional Climate Model

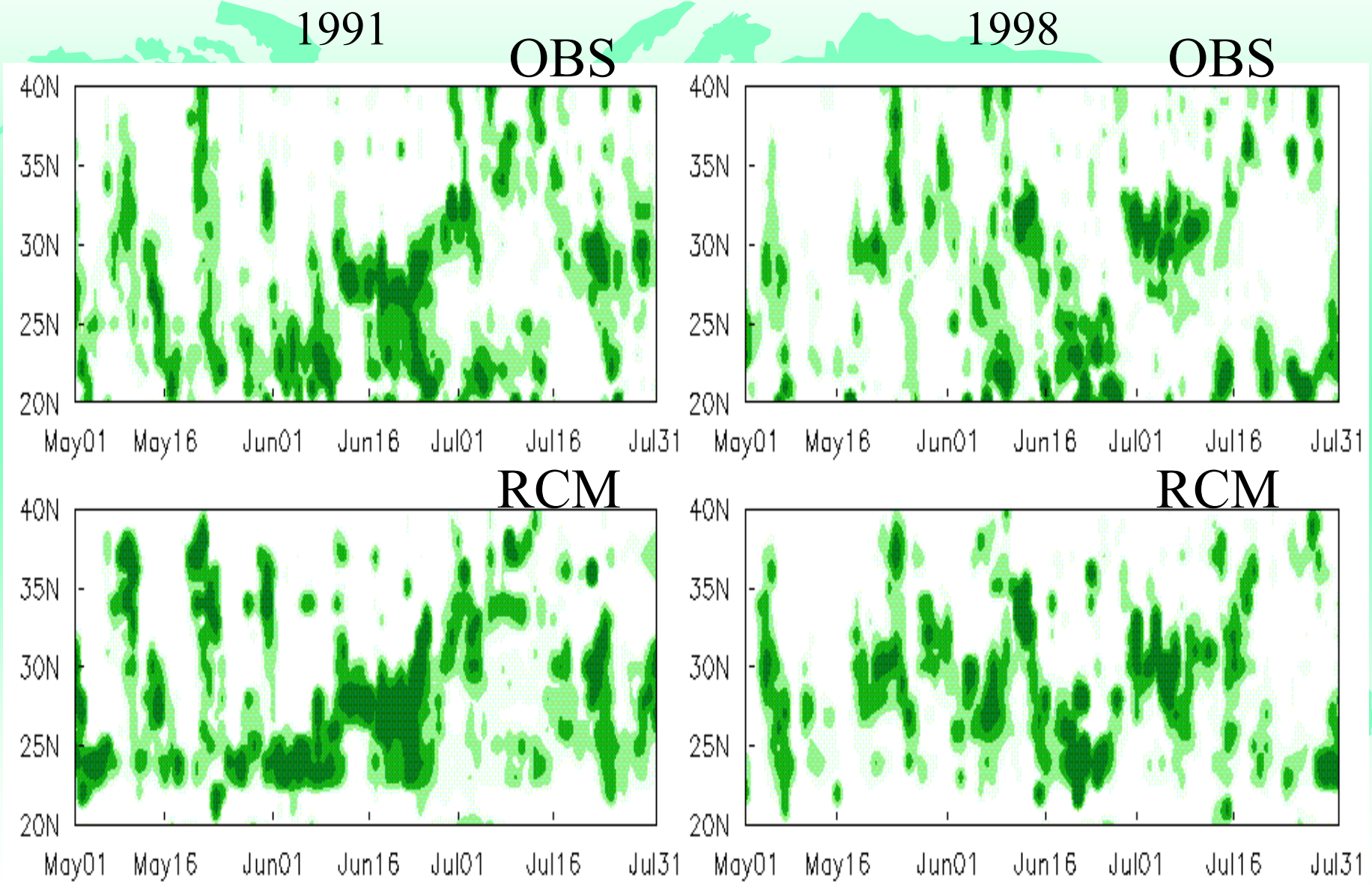
- 85×65 grid points; 23-σ level; 10 mb top; 18 layer lateral buffer zone driven by ECMWF
- Grell et al. (1996) cumulus convection scheme
- Reisner et al. (1998, option 3) for microphysics
- CCM3 radiation package (Kiehl et al., 1996); cloud water diagnostic scheme of CCM3 (Kiehl, 1998); Diagnostic cloud cover scheme of Liang and Wang (1995)
- Xue (1996) land surface model with Mellor-Yamada PBL
- ***Prognostic schemes for cloud water/cover; microphysics***







Latitudinal-time distribution of precipitation

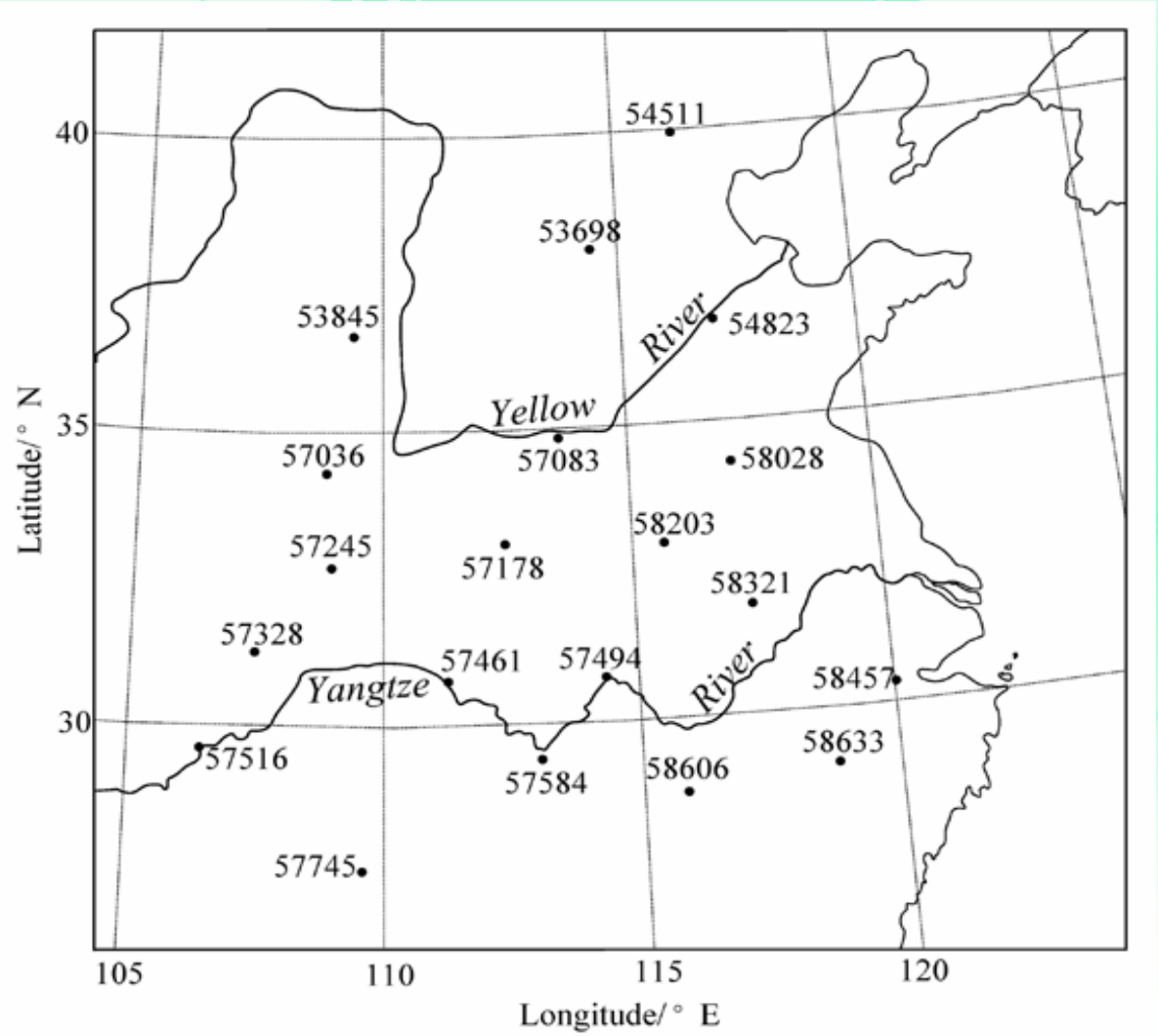


Historical Climate Reconstruction in China:

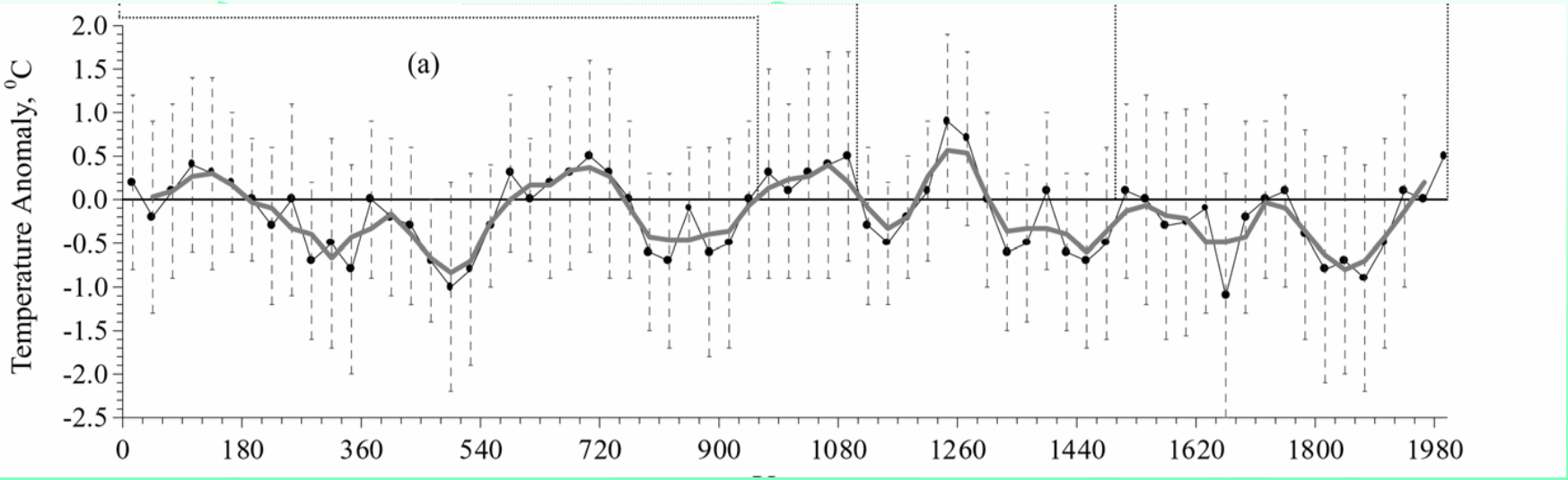
Collaboration between the SUNYA and the Institute of Geographical Sciences and Natural Resource Research , Chinese Academy of Sciences

The phenological cold/warm events recorded in the Chinese historical documents to reconstruct, in 10-30 years resolution, the winter half-year (October-April) temperature of the past 2000 years for the central region (25-40°N and east of 105°E) of Eastern China.

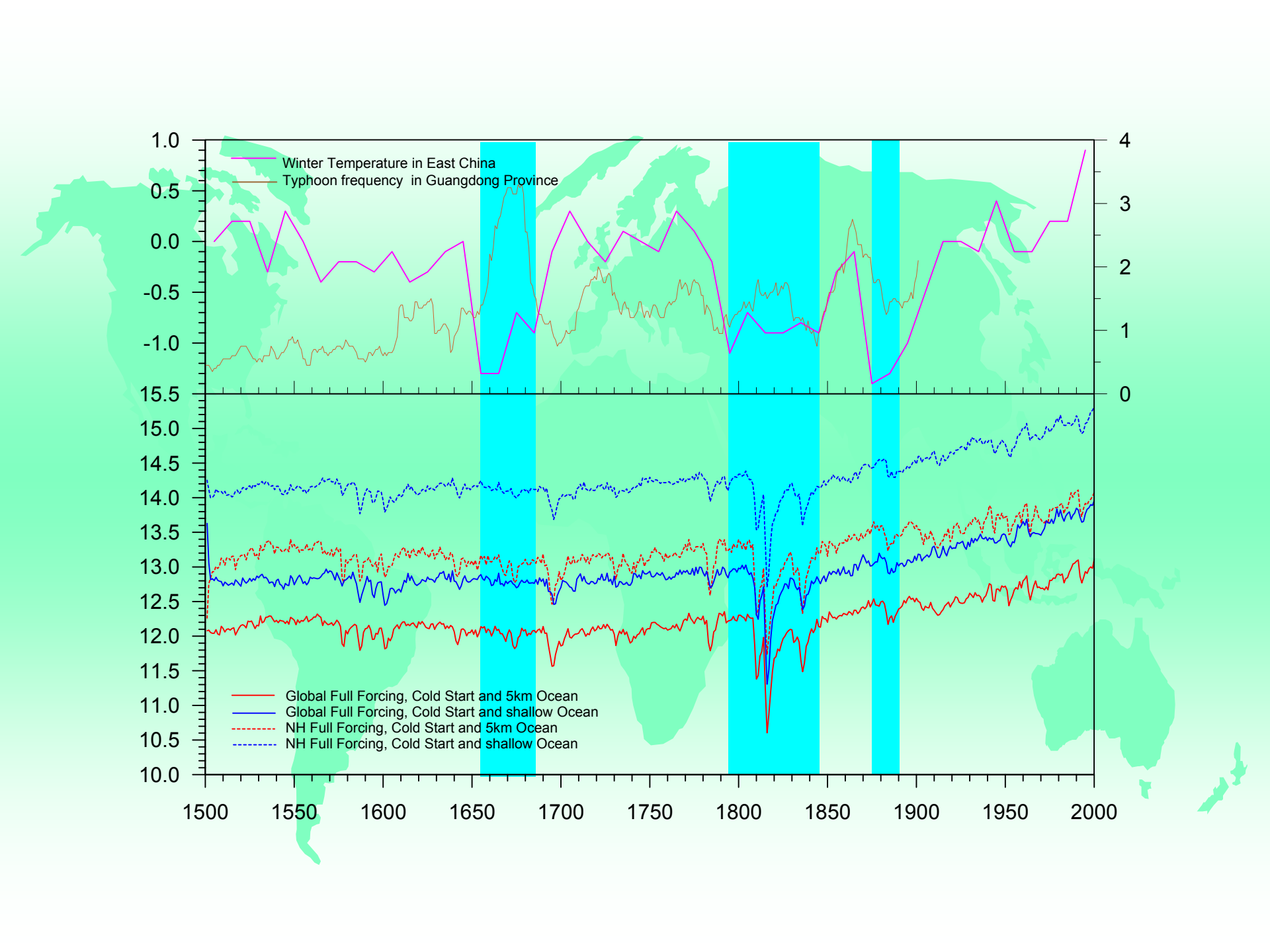
Ge et al. (2003), Holocene, 13, 995-1002.



Winter-half-year temperature anomaly (vs. 1951-1980) in Central Eastern China in the past 2000 years

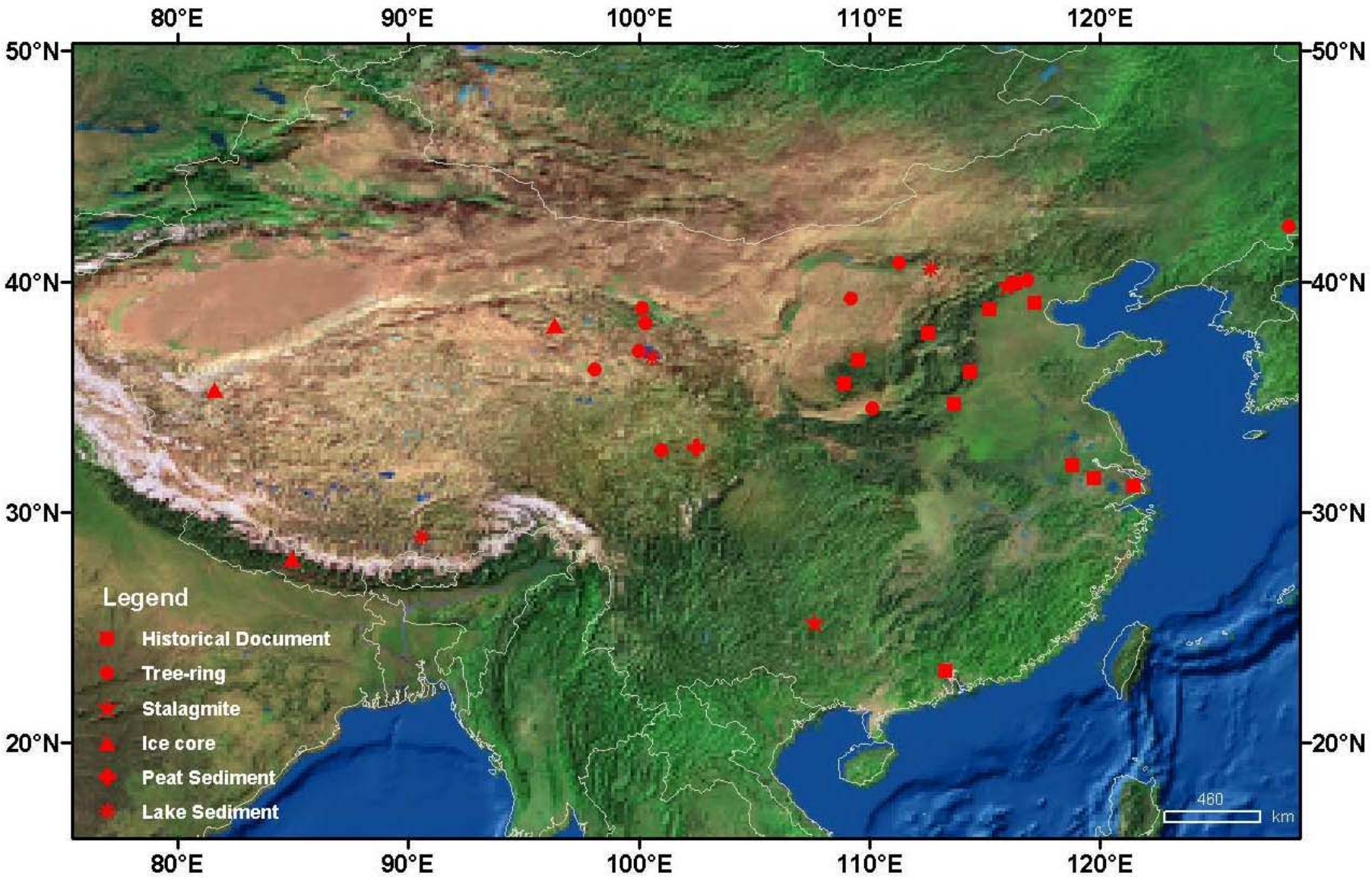


- **1-550 (Cold Epoch)** [cooling at 0.17°C/100a; ~490s reached the lowest level, about 1°C].
- **550-1300 (Warm Epoch)** [temperature rose slowly in fluctuation with a rate of 0.04°C/100a. The 30-year mean temperatures of two warm peaks were generally 0.3-0.6°C higher while a maximum warming of 0.9°C occurred during 1260s-1280s; two cold troughs with 0.5-0.7°C lower]
- **1300-1900 (Cold Epoch)** [Cooling at 0.10°C/100a; the coldest of the four cold troughs, 1.1°C.]
- **1900-2000 (Warm)** [For the period 1981-1999, warmer by 0.5°C.]

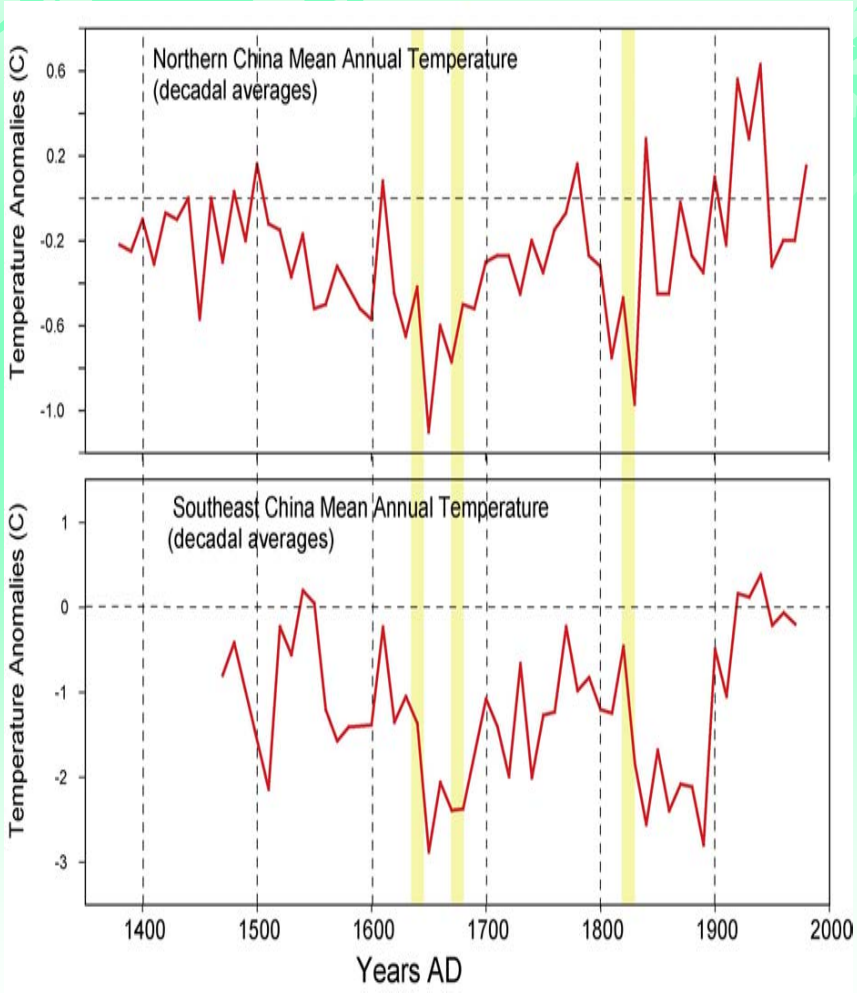

Winter Temperature in East China
Typhoon frequency in Guangdong Province
Global Full Forcing, Cold Start and 5km Ocean
Global Full Forcing, Cold Start and shallow Ocean
NH Full Forcing, Cold Start and 5km Ocean
NH Full Forcing, Cold Start and shallow Ocean
1.0
0.5
0.0
-0.5
-1.0
15.5
4
3
2
1
0
15.0
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
1500
1550
1600
1650
1700
1750
1800
1850
1900
1950
2000

A Paleoclimatic Database Compiled from Proxy Data

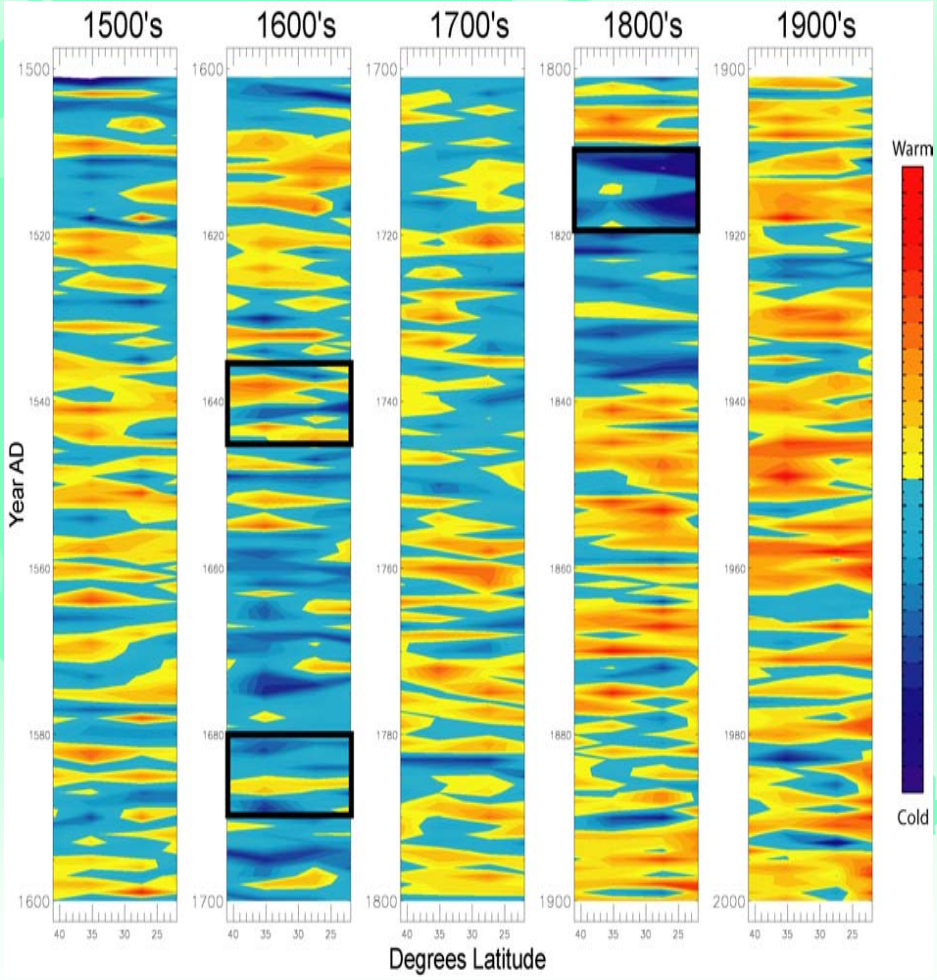
No.	Region Name	Province	Location			Climatic Index	Materials	Time Span			Resulation	Reference
			Lat. N	Long. E	Ele.(m)			Length	Start	End		
1	Beijing	Beijing	39°56′	116°17′	54	P.	Historical D.	277	1724	2000	Annual	Zhang & Wang, 1996
2	Tianjin	Tianjing	39°06′	117°10′	3	P.	Historical D.	275	1736	2000	Annual	Zhang & Wang, 1996
3	Baoding	Hebei	38°50′	115°34′	17	P.	Historical D.	275	1736	2000	Annual	Zhang & Wang, 1996
4	Taiyuan	Shanxi	37°47′	112°33′	778	P.	Historical D.	275	1736	2000	Annual	Zhang & Wang, 1996
5	Zhengzhou	Henan	34°43′	113°39′	110	P.	Historical D.	275	1736	2000	Annual	Zhang & Wang, 1996
6	Kaifeng	Henan	36°36′	109°30′	100	P.	Historical D.	275	1736	2000	Annual	Zhang & Wang, 1996
7	Nanyang	Henan	36°07′	114°22′	76	P.	Historical D.	275	1736	2000	Annual	Zhang & Wang, 1996
8	Yangtze River De	Jiangsu	32°03′	118°47′	9	WT	Historical D.	500	1500	2000	Annual	Zhang et al., 1981
9	East China	Jiangsu, Shangl	31°10′	121°26′	5	T.	Historical D.	550	1450	2000	Annual	Wang et al., 1990
10	Taihu	Jiangsu	31°30′	119°42′	10	WT	Historical D.	500	1500	2000	Annual	Chen, 1992
11	Hefei	Anhui	35°35′	108°55′	1200	WT	Historical D.	264	1737	2000	Annual	Ge et al., in press
12	Pearl River Delta	Guangdong	23°08′	113°19′	7	T.	Historical D.	510	1488	1997	Annual	Li & Zeng, 1998
13	Hulanshan	Ningxia	39°15′	106°10′	2450	ST	Tree-ring	108	1890	1997	Annual	Liu et al., 2002
14	Dulan	Qinghai	36°12′	98°06′	3200	T.	Tree-ring	1600	400	2000	Annual	Yao et al., 2001
14	Huangling	Shanxi	35°35′	108°55′	1200	ST	Tree-ring	100	1891	1990	Annual	Liu et al., 1997
15	Antu	Jilin	42°24′	128°8′	1500	P.	Tree-ring	201	1789	1989	Annual	Liu et al., 1997
16	Daqingshan	Inter Mongolia	40°48′	111°18′	1300	P.	Tree-ring	376	1620	1996	Annual	Liu & Ma, 1999
17	Wulan	Gansu	37°00′	100°00′	3600	T.	Tree-ring	823	1163	1985	Annual	Zu, 1987
18	Qilinshan	Gansu	38°51′	100°08′	3500	SM	Tree-ring	682	1310	1991	Annual	Zhang and Wu, 1995
19	Qilinshan	Gansu	38°12′	100°18′	3400	T.	Tree-ring	572	1414	1985	Annual	Zu, 1987
20	Huashan	Shanxi	34°30′	110°06′	2060	P.	Tree-ring	389	1600	1988	Annual	Hughes et al., 1994
21	Baima	Qinghai	32°42′	101°00′	3400	SP	Tree-ring	265	1723	1987	Annual	Xu & Zhou, 2000
22	Yishan	Shandong	40°03′	116°50′	10	SM	Tree-ring	243	1750	1992	Annual	Shen & Zhang, 1998
23	Shihua Cave	Beijing	39°47′	115°56′	251	ST	stalagmite	2650	665BC	1985	Annual	Tan et al., 2003
24	Guilin	Guangxi	25°12′	107°36′	500	T.	stalagmite	466	1530	1995	Decades	Tan et al., 2000
25	Guliya	Tibet	35°17′	81°39′	6710	T.	Ice core	>2000	?	1991	Annual	Yao &Qin, 1996
26	Dunde	Gansu	38°06′	96°24′	5325	T.	Ice core	>2000	?	1985	Annual	Thompson et al., 1989
27	Dasuopu	Tibet	28°00′	85°00′	6900	T.	Ice core	>2000	?	1996	Annual	Yao et al., 2002
28	Hongyuan	Sichuan	32°46′	102°30′	3466	T.	Peat	>2000	BC	1950	Decades	Xu et al., 2002
29	Daihai Lake	Inter Mongolia	40°33′	112°39′	220	T.	Lake S.	1000	?	1990	Decades	Cao et al., 2000
30	Qinghai Lake	Qinghai	36°42′	100°33′	3200	T.	Lake S.	1000	1000	2000	Decades	Shen et al., 2002
31	Chen Co	Tibet	28°57′	90°36′	4438	T.	Lake S.	1300	700	2000	Decades	Zhu et al., 2001


80°E
90°E
100°E
110°E
120°E
50°N
40°N
30°N
20°N
Legend
Historical Document
Tree-ring
Stalagmite
Ice core
Peat Sediment
Lake Sediment
480
km

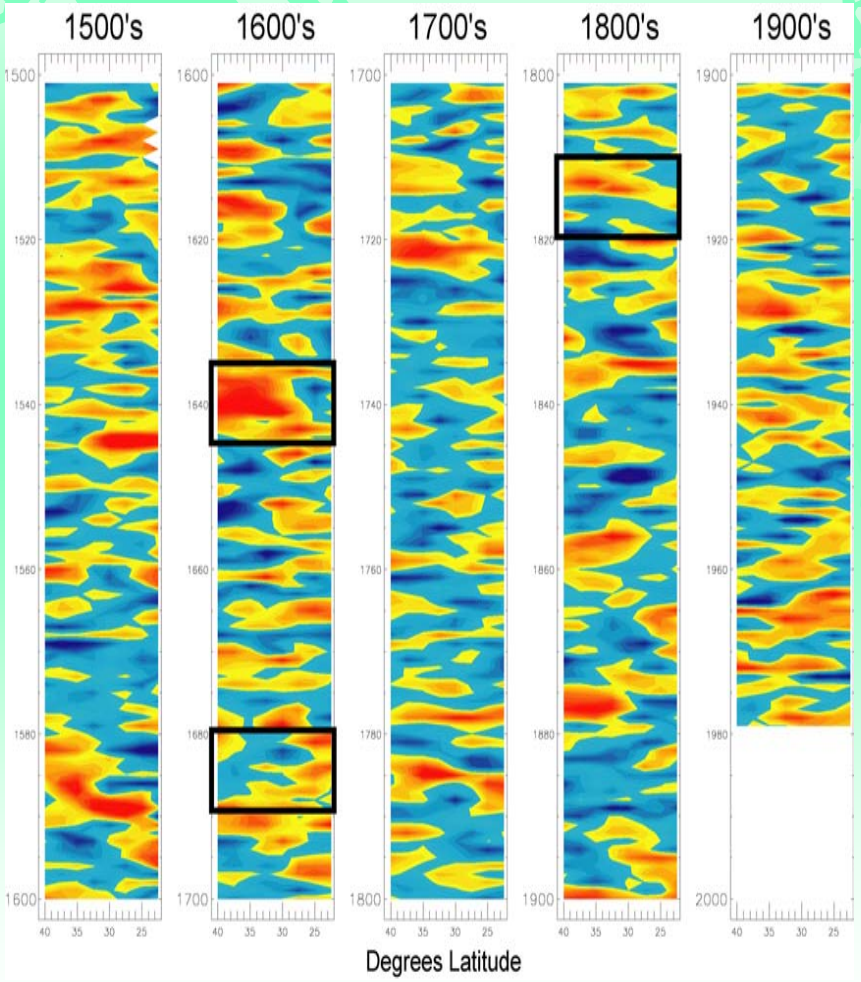
Historical Reconstructed Temperature



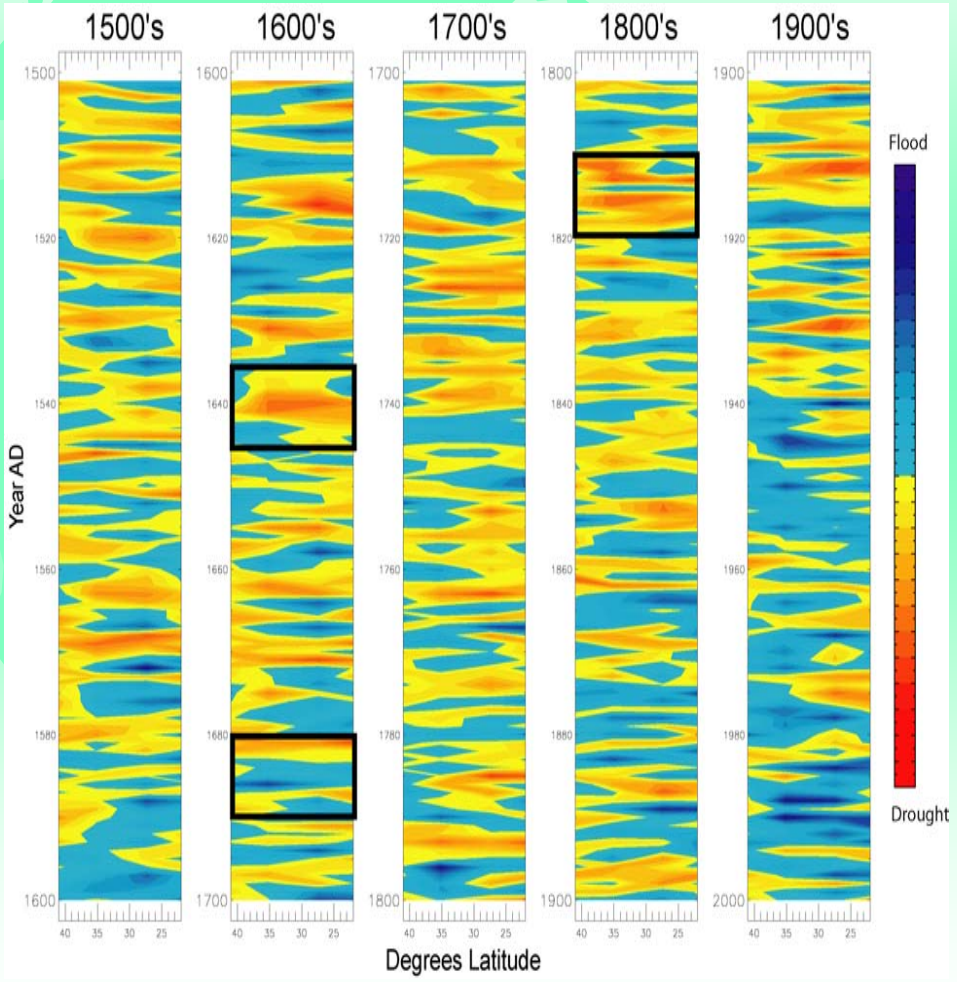
GISS Modeled Temperature



Historical Dryness/ Wetness Index



GISS Modeled Precipitation



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Research Strategy